REMARKS/ARGUMENTS

In response to the Office Action dated January 5, 2006, Claims 1-25, 27, 28, 30-35, 38-50, 63 and 75-81 remain in this application. Claims 1, 7, 27, 30-32, 34, 35, 43 and 44 have been amended. Claims 26 and 29 have been cancelled.

Claim 43 was objected to.

Claims 34 and 35 were rejected under 35 USC 112.

Claims 1-5, 12-25, 32, 33, 38, 39, and 63 were rejected under 35 USC 102.

Claims 6-11, 26-31, 34, 35, 40-50, and 75-81 were rejected under 35 USC 103.

Claims 1-35, 38-50, 63, and 75-81 were rejected under obviousness-type double patenting.

Claim Objections

Claim 43 is objected to as it recites that the offset frequencies are centered around 10 MHz and a review of the Specification (Page 106) indicates that the claim should rather recited 13.56 MHz.

Applicants hereby amend Claim 43 and appropriate correction has been made.

Claim Rejections - 35 USC § 112

Claims 34 and 35 are rejected under 35 USC 112, second paragraph, as being indefinite for failing to particularly pint out and distinctly claim the subject matter which applicant regards as the invention. In Claim 34, the limitation "said first and second RF power sources" in Line 5 was held to have insufficient antecedent basis. Claim 34 has been amended to depend from Claim 1, and the amendment of Claim 1 overcomes this rejection.

In Claim 35, the limitation "said ports" in Line 1 was held to have insufficient antecedent basis. Claim 35 has been amended to replace the term "ports" with "openings" in order to overcome this rejection.

Claim Rejections - 35 USC 102

Claims 1-5, 12-25, 32, 33, 38, 39, and 63 are rejected under 35 USC 102(e) as being anticipated by Mahoney et al. (US Pat. No. 6,432,260). Claim 1 has been amended to specify the features of a pair of transverse (or perpendicular) hollow conduits terminated in openings that are displaced on opposite sides (180 degrees offset from one another) of the chamber, so that the reentrant paths of the toroidal plasma currents each run the entire diameter of the process region. Since the two reentrant paths cross and intersect one another in the process region, the plasma coverage of the process region overlying the wafer is more uniform compared to the prior art, a significant advantage. Note that Shunko's multiple paths are all very short relative to the process region (about a quarter diameter of the wafer, at most) because their terminations (openings) lie close to one another (are offset by relatively small angles, e.g., only 45 degrees, along the arc of his sidewall). Moreover, none of Shunko's toroidal paths appear to intersect. In view of these differrences, it is not possible for Shunko to suggest the features of Claim 1. Shunko is not even attempting to achieve such features, nor does he appear to be concerned with toroidal plasma uniformity in the process region. Accordingly, it is felt that Claim 1 as amended is patentable based upon the following claim language:

> *"each pair of openings being separated from one another by a distance approximately equal to the diameter of said workpiece support, whereby the two openings of*

each pair are adjacent respective points along said side wall that are 180 degrees apart along the circumference of said side wall; . . . first and second mutually transverse hollow conduits outside of said chamber, . . . , so as to provide first and second mutually transverse reentrant paths . . . intersecting one another in said process region."

Claims 2-5, 12-25, 32, 33, 38, 39, and 63 depend from Claim 1 and are therefore patentable upon the same basis.

Claim Rejections - 35 USC 103

First Rejection: Claim 6 is rejected under 35 USC 103(a) as being unpatentable over Mahoney et al. in view of Smith et al. (US Pat. No. 6,150,628).

Claim 6 is patentable because the present invention has the first external conduit formed of metal and with a dielectric ring within it, in which the toroidal path extends through the process region at the workpiece (or pedestal) surface. Note that Smith et al. fails to teach a toroidal path passing through the process region AND fails to teach an *external* conduit forming a part of the toroidal path in which the conduit is separate from the chamber so that the path is reentrant to the chamber. In Smith et al., the entire path is contained inside the chamber, which must therefore be entirely surrounded by large external magnetic cores 104, 106. Applicants' external reentrant path provides a significant advantage over Smith et al. because in the present invention a small magnetic core wrapped around a small section of the external conduit provides the requisite source power applicator. Thus, the external reentrant conduit is a significant advantage in and of itself. Therefore, the combination with a dielectric ring to enable the external conduit

to be formed of metal is a non-obvious combination that renders Claim 6 patentable based upon the following claim language:

> *. . . first and second mutually transverse hollow conduits outside of said chamber (Claim 1) . .*
>
> *. . . an annular insulating gap in said first hollow conduit separating said first hollow conduit into axial sections (Claim 6).*

Second Rejection: Claims 7-11, 40-42, and 75-81 are rejected under 35 USC 103(a) as being unpatentable over Mahoney et al. in view of Ishii et al. (US Pat. No. 5,571,66). These claims depend from Claim 1 and are therefore patentable upon the same basis. The differences between Claim 1 as amended and Mahoney are discussed above. Ishii is less relevant than Mahoney because Ishii is not related to toroidal plasma sources.

The feature of Claim 7 in which the closed reentrant path of the toroidal plasma is constricted in the process region (only) appears to be unappreciated in the rejection. In the invention of Claim 7, the plasma ion density is not limited by the source power level. The examiner suggests that Ishii can simply raise his workpiece pedestal to increase his ion density proportionately, but this is not exactly the case. The reason is that Ishii has no toroidal plasma current. The plasma generation region and the plasma process region in Ishii are both beneath his source power applicator, so that plasma ion density can be increased proportionately by raising his pedestal toward the ceiling ***only*** if it is assumed that all Ishii's source power will continue to be coupled exclusively into the region between the ceiling and the wafer, even as the wafer is raised toward the pedestal. That assumption cannot be completely relied upon. In contrast, in the invention of Claim 7, the toroidal plasma has its source power applied in the external conduit while the

resulting current circulates through the process region over the wafer. Narrowing the ceiling-to-wafer distance (volume) necessarily produces a proportional increase in plasma ion density in the process region due to the conservation of current: all the current generated in the external conduit passes through the process region. Thus, low plasma ion density in the external conduit is transformed to a high plasma ion density in the process region by simply constricting the cross-sectional area of the plasma current over the wafer. This feature has no corollary in Ishii because there is no circulating current in Ishii. Therefore, there is no such advantage in Ishii. Accordingly, it is felt that Claim 7 is clearly patentable based upon the following claim language:

> *said ceiling comprises a constriction of said reentrant torroidal path in said process zone for enhancement of plasma ion density of said plasma current in said process zone.*

Third Rejection: Claims 26-30, 34, 35, 43, and 44 are rejected under 35 USC 103(a) as being unpatentable over Mahoney et al. in view of Shun'ko (US Pat. No. 6,392,351). Claim 26 is cancelled while the remaining claims (27-30, 34, 35, 43, 44) depend from Claim 1 and are patentable upon the same basis.

Fourth Rejection: Claims 31 and 45-50 are rejected under 35 USC 103(a) as being unpatentable over Mahoney et al. in view of Arami et al. (US Pat. No. 5,958,140).

Claim 31 claims the placement of the gas distribution plate in the center of the circular toroidal plasma current path, with the gas distribution plate serving as one boundary of the toroidal path within the process region. This is distinguished from a conductive gas distribution plate in the ceiling with a

capacitively coupled plasma source, such as Arami. Inductively coupled plasma sources in the ceiling are incompatible with a conductive gas distribution plate. The toroidal reactor of Claim 31 has a gas distribution plate directly over the workpiece (a significant advantage) that can be of a conductive material without interfering with the plasma source. Therefore, the combination of Claim 31 is patentable, based upon the claim language:

> *gas distribution plate being located in a region of said ceiling that is radially inward of said first and second pairs of openings, whereby said gas distribution plate is surrounded by said each of said reentrant paths and forms a boundary of the portion of each reentrant path lying within said process region.*

It should be noted that Claim 31 specifies a ceiling that is both a gas distribution plate surrounded by the toroidal plasma current and a constricting boundary to the plasma current that raises the plasma density in the process region, so that less source power can be applied at the external conduit (using a much smaller core than the prior art of Smith) for a given plasma density, and a dielectric ring is used in the external conduit. It is felt the foregoing is an unobvious combination of elements that together provide advantages not realized in the prior art.

Claims 45-50 depend from Claim 1 and are therefore patentable upon the same basis.

Double Patenting

Claims 1-35, 38-50, 63, and 75-81 are rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1-3, 7, 10-13, 26, and 27 of U.S. Pat. No. 6,348,126; or alternatively over claims 1, 2, 9, 12, 15, 18, and 20 of U.S. Pat. No. 6,468,388; or alternatively over claims

1-4, 7, and 8 of U.S. Pat. No. 6,494,986; or alternatively over claims 1, 2, and 4 of U.S. Pat. No. 6,551,446; each in view of Mahoney et al., Smith et al., Ishii et al., Shun'ko, and Arami et al.

Applicants submit herewith a Terminal Disclaimer to obviate the double patenting rejection over U.S. Pat. No. 6,348,126. Applicants submit here with a Terminal Disclaimer to obviate the double patenting rejection over U.S. Pat. No. 6,468,388. Applicants submit here with a Terminal Disclaimer to obviate the double patenting rejection over U.S. Pat. No. 6,494,986. Applicants submit herewith a Terminal Disclaimer to obviate the double patenting rejection over U.S. Pat. No. 6,551,446.

Claims 1-35, 38-50, 63, and 75-81 are provisionally rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1 and 14-16 of co-pending Application No. 10/646,527; or alternatively over claims 1-3 of co-pending Application No. 10/646,533.

Applicants submit here with a Terminal Disclaimer to obviate the double patenting rejection over co-pending Application No. 10/646,527. Applicants submit here with a Terminal Disclaimer to obviate the double patenting rejection over co-pending Application No. 10/646,533.

SUMMARY

In view of the foregoing corrections and remarks, it is felt that the objections to the claims, rejections to the claims under 35 USC 112, 2nd paragraph, 35 USC 102(e), 35 USC 103(a) and the double patenting rejection of the claims have been overcome. Therefore, withdrawal of these rejections is respectfully requested and allowance of the application is earnestly solicited.

If, however, the Examiner believes that there are any unresolved issues requiring adverse final action in any of the claims now pending in the application, the Examiner should telephone Robert Wallace at (805) 644-4035 so that appropriate arrangements can be made for resolving such issues as expeditiously as possible.

Respectfully submitted,

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